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CONFIDENTIAL

SET A

UNIVERSITI KUALA LUMPUR
Malaysia France Institute

FINAL EXAMINATION

JANUARY 2014 SESSION

SUBJECT CODE	:	**FAB 30503/FAB 30903**
SUBJECT TITLE	:	**MECHATRONICS SYSTEM DESIGN** **MECHATRONICS DESIGN PROJECT**
LEVEL	:	**BACHELOR**
TIME / DURATION	:	**(3 HOURS)**
DATE	:	

INSTRUCTIONS TO CANDIDATES

1. **Please read the instructions given in the question paper CAREFULLY.**
2. **This question paper is printed on both sides of the paper.**
3. **Please write your answers on the answer booklet provided.**
4. **Answer should be written in blue or black ink except for sketching, graphic and illustration.**
5. **This question paper consists of TWO (2) sections. Section A and B. Answer all questions in Section A. For Section B, answer THREE (3) questions only.**
6. **Answer all questions in English.**

THERE ARE 8 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer all the questions.
Please use the answer booklet provided.

Question 1

(a) The technical term of “mechatronics” was coin by Mr. Tetsuro Mori in 1969 when he worked for Yaskawa Electrics Corporation in Japan. Define “Mechatronics” and list **two (2)** examples of mechatronics system.

(3 marks)

(b) Describe **four (4)** key elements in mechatronics.

(4 marks)

(c) A simple physical system with a few sensors and actuators need to be integrating with a computer system. Draw and label a block diagram of complete mechatronics system with the essential elements of mechatronics.

(5 marks)

(d) Explain the different between open-loop and closed-loop control system and give an example of each system.

(4 marks)

(e) Explain the power system and give two examples of power system devices.

(4 marks)

Question 2

(a) Describe product development and give **one (1)** example of product.

(3 marks)

(b) List **four (4)** dimensions of quality of successful product.

(4 marks)

(c) Illustrate with a block diagram a step by step of product planning.

(5 marks)

(d) Define ‘Stackholders’.

(2 marks)

(e) List **two (2)** discrete activities in conceptual design.

(2 marks)

(f) The product live cost and profit cycle can be divided into **two (2)** phases; premarket phase and market phase. Define them.

(4 marks)

SECTION B (Total: 60 marks)

INSTRUCTION: Answer only THREE (3) questions.
Please use the answer booklet provided.

Question 3

(a) Selecting the right sensors depends on the particular need for the parameter being measured. List **four (4)** criteria that the engineer should address before selecting the sensor.

(4 marks)

(b) Refer to **Figure 1;** describe the working operation of inductive proximity sensor.

(4 marks)

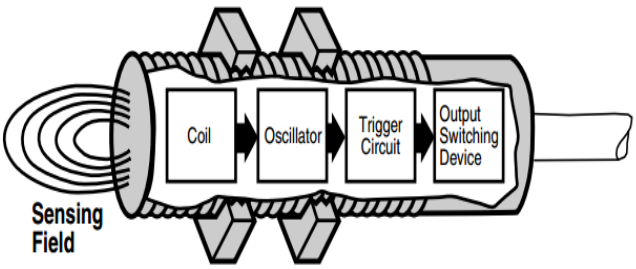

Figure 1: Inductive proximity sensor

(c) Illustrate with a block diagrams a step by step of signal conditioning process.

(5 marks)

(d) The term filtering is the process of removing a certain band of frequencies from a signal and permitting others to be transmitted. List **two (2)** types of filter and define them.

(4 marks)

(e) Consider the situation where the microprocessor gives and output of an 8 bit word. This is fed through and 8 bit digital to analog converter to a control valve. The control valve required 6 V to be fully open. If the fully open state is indicated by 1111 1111, calculate the output of the valve for a change of 1 bit.

(3 marks)

Question 4

Figure 2 shows a schematics diagram of PIC 16F877A wiring diagram. This is a simple application on how to start a basic PIC programming.

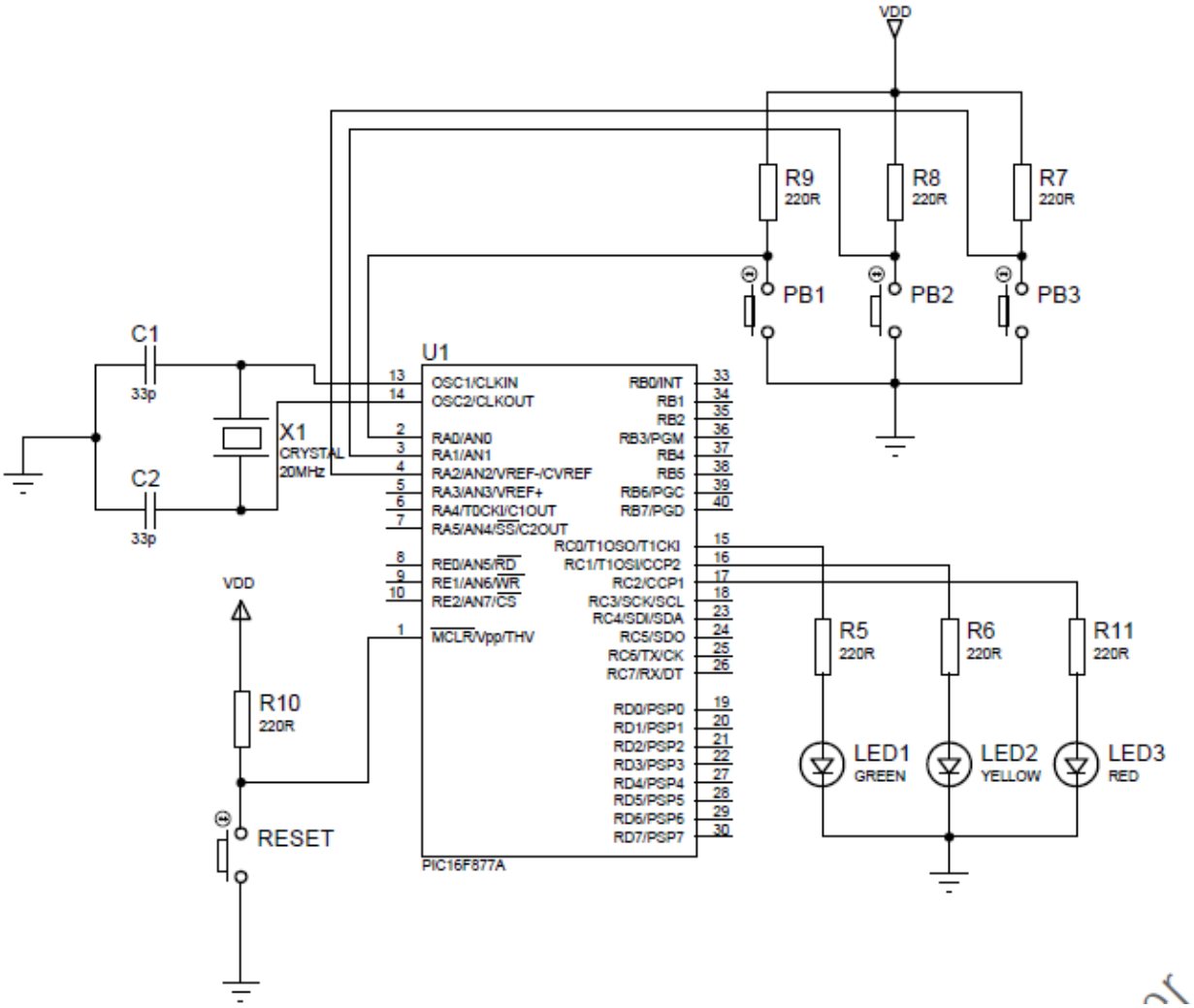

Figure 2: Schematic of PIC16F877A

(a) Determine the inputs and outputs of the PIC. (2 marks)

(b) Describe the functionality of the component label X1, CRYSTAL, 20MHz.

(2 marks)

(c) Create a program of pin configuration for push buttons (PB) and LEDs at PORT A and PORT C.

(4 marks)

(d) Based on **Figure 3** and **Figure 4** create a main program of LED blinking pattern 1 and pattern 2. Pattern 1 will be blinked if PB1 is pressed. LED 1 and LED 2 will be blinked together and then after a few second LED 2 and LED 3 will be blinked together and it will repeat until PB3 is pressed to stop the operation. Pattern 2 will be blinked if PB2 is pressed. Call function `delay_ms(100)` for delay. The header file should be as follows:

```
#define PB1 RA0
#define PB2 RA1
#define PB3 RA2
#define LED1 RC0
#define LED2 RC1
#define LED3 RC2
```

(10 marks)

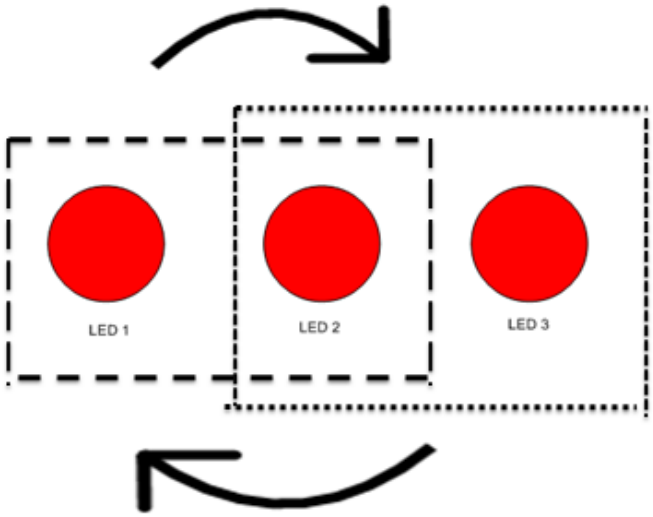

Figure 3: Pattern 1

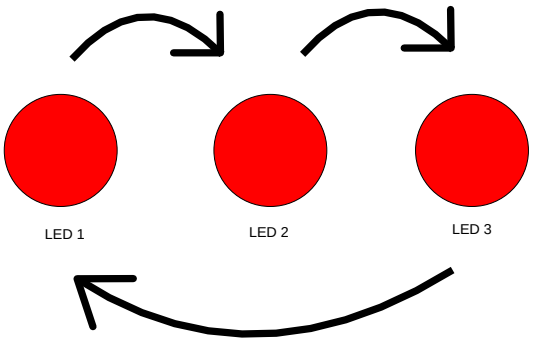

Figure 4: Pattern 2

(f) A microcontroller PIC 16F877A have a few 8-bit bidirectional port. Explain the meaning of 'TRISA = 0xF3' in term of input and output bits, if this statement is stated in the programming step.

(2 marks)

Question 5

(a) Consider three meshed gear wheels A, B and C in **Figure 5.** If there are 40 teeth on wheel A, 80 teeth on wheel B and 120 teeth on wheel C, find the overall gear ratio of the angular velocities at the input and output shafts.

(6 marks)

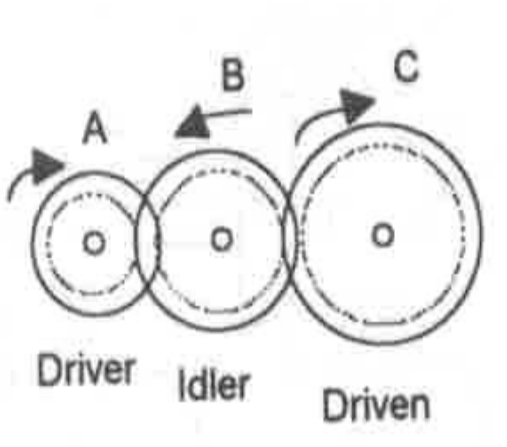

Figure 5: Three meshed gear wheels

(b) A cam follower, also known as a track follower, is a specialized type of roller or needle bearing designed to follow cams. List a type of cam follower that is illustrated in **Figure 6**.

(6 marks)

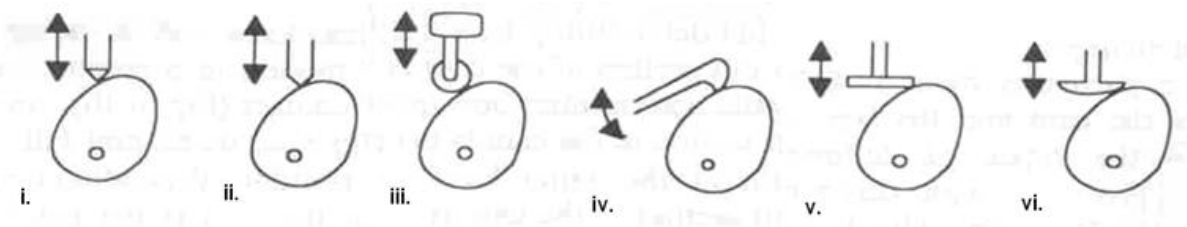

Figure 6: CAM follower.

(c) Refer to **Table 1**, find the valve size that is required to control the flow of water when the maximum flow required is 0.012m^3/s and the permissible pressure drop across the valve at this flow rate is 300 kPa. Density of water is about 1000 kg/m^3.

(4 marks)

Table 1: Flow coefficient and flow control valves.

Flow coefficients	Valve size (mm)							
	480	640	800	960	1260	1600	1920	2560
C_V	8	14	22	30	50	75	110	200
$A_V \times 10^{-5}$	19	33	52	71	119	178	261	474

(d) Draw a pneumatic circuit for extend and retract cylinder by using 3/2 way valve.

(4 marks)

Question 6

(a) List 2 key steps of modeling methodology.

(2 marks)

(b) Initially, there is no current flow in the circuit and the switch is in open position. At time *t*=0, the switch is places in closed position and voltage *e* is applied. Current starts to build up in the circuit and starts charging the capacitor. The voltage in the circuit at time t is given by:

resistor voltage + inductor voltage + capacitor voltage = applied voltage

Determine the transfer function for voltage *I*(s) and applied input $E(s)$ for the following circuit:

(8 marks)

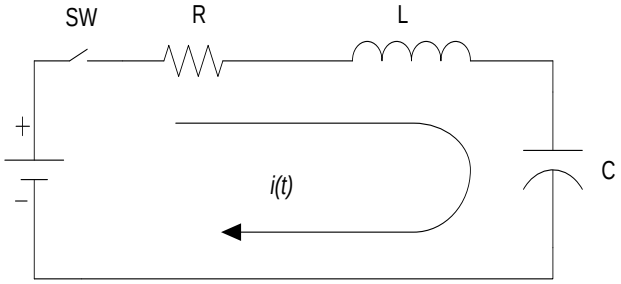

Figure 7: RLC Circuit

(c) **Figure 8** shows the **two (2)** tanks connected in series that fluid level in downstream tank does not affect the fluid-level dynamics of the upstream tanks**.**

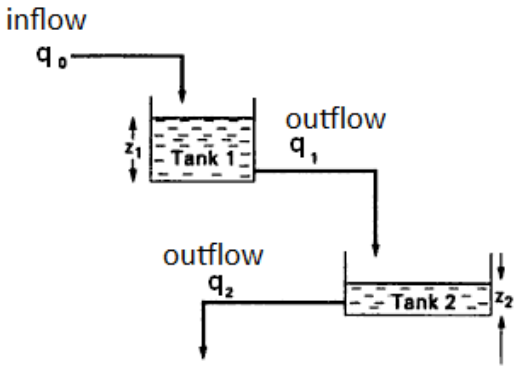

Figure 8: Noninteracting tanks

Variables used:

z_1 = fluid level in the upstream tank (1)
z_2 = fluid level in the upstream tank (2)
q_0 = fluid flow rate into tank 1
q_1 = fluid flow rate out of tank 1 and into tank 2
q_2 = fluid flow rate out of tank 2
R_1 = resistance of the tank 1 outlet
R_2 = resistance of the tank 2 outlet

Find the transfer function; $\frac{Z_1(s)}{Q_0(s)}$ of tank 1.

(5 marks)

(d) A spring mass damper system is shown in **Figure 9**. The system is fixed at ends between two supports. Mass is supported by the spring and is free to oscillate about the position of rest. An equation of motion relating vertical motion of mass to applied force will be developed.

Where mass force + damping force + spring force = External Force

$$M\frac{d^2x(t)}{dt^2} + B\frac{dx(t)}{dt} + Kx(t) \quad = \quad F(t)$$

The differential equation above describes the behavior of spring, mass and damper system, where;

F = External Force
B = Damping force
M = Mass Force
K = Spring Force

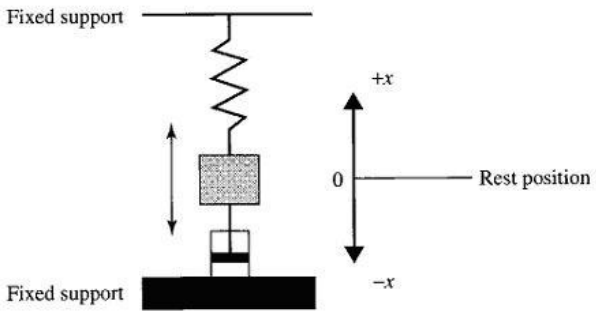

Figure 9: The spring mass damper system

Find the Transfer Function of the system where *X(s)* = Mass movement and *F(s)* = Applied Force

And

$$TF(s)=\frac{X(s)}{F(s)}$$

All the initial condition = 0

(5 marks)

END OF QUESTION